EXHIBIT 2

Annual Research Review: Adolescent mental health in the digital age: facts, fears, and future directions

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Abstract:

Adolescents are spending an increasing amount of their time online and connected to each other via digital technologies. Mobile device ownership and social media usage have reached unprecedented levels, and concerns have been raised that this constant connectivity is harming adolescents' mental health. This review synthesized data from three sources: (a) narrative reviews and meta-analyses conducted between 2014 and 2019, (b) large-scale preregistered cohort studies and (c) intensive longitudinal and ecological momentary assessment studies, to summarize what is known about linkages between digital technology usage and adolescent mental health, with a specific focus on depression and anxiety. The review highlights that most research to date has been correlational, focused on adults versus adolescents, and has generated a mix of often conflicting small positive, negative and null associations. The most recent and rigorous large-scale preregistered studies report small associations between the amount of daily digital technology usage and adolescents' well-being that do not offer a way of distinguishing cause from effect and, as estimated, are unlikely to be of clinical or practical significance. Implications for improving future research and for supporting adolescents' mental health in the digital age are discussed.

Article:

Introduction

Adolescents have been early and enthusiastic adopters of digital technologies. Nearly all adolescents (95%) in the United States have at least one mobile device of their own, and 89% own a smartphone (Rideout & Robb, **2018**). Similarly, a 2014 study of young people between the ages of 9 and 16 living across seven European countries reported that 80% of youth owned either a mobile or smartphone (Mascheroni & Ólafsson, **2014**). Worldwide, rates of Internet and mobile

phone access vary dramatically across high versus low-income countries; however, overall, one in three users of the Internet worldwide are under the age of 18 (Keeley & Little, **2017**) and across both advanced and emerging economies younger (under the age of 35) versus older people (Taylor & Silver, **2018**) are more likely to have access to the Internet, smartphones and social media.

Access to mobile devices begins early. Among our sample of young adolescents attending public schools in a large Southeastern state, close to half (48%) of 11-year-olds reported owning a mobile phone with a steep increase in ownership to 85% of adolescents by age 14 (Odgers, **2018**). Young people are also spending an increasing amount of time online, with recent estimates in the United States placing older adolescents (aged 13–18) online viewing of screen media for nonschool purposes at 6.67 hr per day, with their younger peers (aged 8–12) spending, on average, 4.6 hr on screen media each day (Rideout, **2015**).

Adolescents' constant connectivity has led to concerns about how digital technologies may be influencing multiple aspects of adolescents' lives, ranging from their levels of physical activity and their ability to interact with others in 'real life' to a more recent focus on whether too much time online is contributing to mental health problems among young people. Discussions about the potential negative effects of smartphones and social media are taking place alongside growing concerns regarding adolescents' mental health. Recent increases in rates of depression, anxiety and suicide, especially among girls (Mojtabai, Olfson, & Han, **2016**) who are the heaviest users of new media, have led some to claim that smartphones and social media may be driving increases in suicidal behaviors, depression, and loneliness (Rosenstein & Sheehan, **2018**; Twenge, Joiner, Rogers, & Martin, **2018**). Alternative explanations for these increases have been provided and skepticism voiced regarding the claim that digital technology usage has led to increases in adolescent depression and related mental health problems (Daly, **2018**; Livingstone, **2018**); however, much of the conversation about contemporary adolescents' mental health implicates digital technology usage as contributing to the worsening of mental health symptoms and well-being.

This paper reviews existing research regarding the association between digital technology use and mental health, with a specific emphasis on the potential influences of digital technology usage on adolescents' experiences of depression and anxiety. The review integrates three main sets of information including recent: (a) meta-analyses summarizing the associations between digital technology usage and mental health among youth, (b) findings from large-scale public access surveys and preregistered studies, and (c) studies that have leveraged daily assessments of digital technology usage to understand both within- and between-person associations between adolescents' digital technology usage and mental health. These three sources of information are triangulated to address the question of whether there are robust and practically significant associations between digital technology usage and adolescent mental health and, if so, for whom and under what circumstances digital technology usage may amplify or reduce risk. Given a) the rapidly evolving nature of digital technologies usage among adolescents and b) the fact that a number of reviews and meta-analyses have recently been completed on this topic, a formal meta-analysis is not included. Instead, a synthesis of the main findings from recent reviews is provided alongside a review of key findings from large-scale datasets and daily and momentary studies. Finally, a set of future directions for research, policy and interventions are proposed, alongside a

description of the steps that researchers, clinicians and policymakers will need to take to effectively support adolescents' mental health in the digital age.

What do we currently know about the association between adolescent depression, mental health problems and digital technology usage?

In the United States, there have been rapid and unprecedented increases in adolescent depressive symptoms (Keyes, Gary, O'Malley, Hamilton, & Schulenberg, **2019**) and suicidal behavior (Burstein, Agostino, & Greenfield, **2019**; Naghavi, **2019**). Deaths by suicide have increased among every age group, but have been especially drastic among girls, where there has been a tripling of the suicide rate among 10- to 14-year-old girls from 1999 through 2017 (Hedegaard, Curtin, & Warner, **2018**). It is important to note that the United States is an outlier with respect to these trends as rates of suicide worldwide continue to fall (Naghavi, **2019**); nonetheless, secular increases in emotional problems among young people have been observed, with increases in self-reported symptoms of anxiety and depression documented in countries such as Greece, Germany, Sweden, Iceland, Norway, China, and New Zealand from the 1980s onwards (Collishaw, **2015**).

These increases have sounded alarms among parents, care providers and educators given the burden of disease and potentially devastating and deadly consequences for youth and their families. When plotted alongside increases in social media usage across this same time period, a powerful narrative has emerged that social media is driving changes in depressive symptoms and suicidal behaviors. Of course, the fact that two trend lines increase together does not mean that one phenomenon causes the other. Nonetheless, social media and digital technology usage has quickly emerged as a leading candidate to explain the sudden jump in depression and related problems among girls.

Historically, adolescents who spent more time online were also more likely to report symptoms of depression and anxiety. But, these data come from a time when only a minority of young people were online, engaging in very different activities than what is seen today (in chat rooms talking with strangers versus online connecting with peers (George, Russell, Piontak, & Odgers, **2018**). Today, the majority of adolescents are online, typically connecting with offline friends and family (Reich, Subrahmanyam, & Espinoza, **2012**). Moreover, as suggested by a recent synthesis of 37 studies, online communication between young people is typically being used to support the 'traditional' tasks of offline friendships through arranging meet-ups, developing intimacy, and shows of affection (Yau & Reich, **2017**).

Small associations still exist, as adolescents who report more depressive symptoms also tend to report spending more time online. However, as detailed below, a review of meta-analytic work and narrative reviews, recent large-scale public access and preregistered studies, and daily and momentary assessments of digital technology usage and mental health, show that that associations between time online and internalizing symptoms are often (a) mixed between positive, negative, and null findings, (b) when present, are likely too small to translate into practically or clinically meaningful effects (explaining less than 0.5% of the variance in symptoms with poor adjustment for relevant confounding factors and estimates that are virtually always derived from correlation designs), and (c) are typically not distinguishable in terms of

likely cause and effect. In addition, a recent systematic narrative review of 28 studies of online help-seeking behaviors indicated that many young people suffering from mental health problems are spending their time online searching for means of alleviating and better understanding their symptoms (Pretorius, Chambers, & Coyle, **2019**).

Evidence Base 1. Meta-analytic studies and reviews

Six recent reviews summarizing the associations between digital technologies and adolescents' mental health completed between the years of 2014 to 2019 are described below. The reviews were selected due to the fact that they targeted or included adolescent populations and included a focus specifically on the associations between amount of digital technology usage and mental health (see Table **1**). The main results from each review are described briefly below, followed by a synthesis of findings and limitations across this work. Details on the individual studies included in the reviews are also provided in Table **S1**.

Table 1. Recent Reviews on Youth Digital Technology Use and Mental Health

	Study Design	**Sample Age Mean (range)**	**Sample size**	**Mental health measure**	**Tech use measure**
Best et al. (2014)	Systematic narrative review	Adolescents	43 studies	Mental health and well-being	Online communication and social media
Baker et al. (2016)	Systematic review of quant studies	Adolescents and Adults	30 studies	Depression	SNS
Seabrook et al. (2016)	Systematic review	Adolescents and Adults	70 studies	Depression and anxiety emphasis; Overall well-being	SNS
Huang (2017)	Meta-analysis	Adolescents and Adults	67 samples (61 studies) ($N = 19,652$)	Self-esteem, life satisfaction, loneliness and depression	SNS
Keles et al. (2019)	Systematic review	13-18	13 papers	Depression, anxiety and distress	Social media
McCrae et al. (2017)	Systematic review	5 to 18	11 studies ($N = 12,646$)	Depression	Social media

SNS, Social Networking Site.

Three of the six reviews focused exclusively on adolescent or child populations. In one of the earliest and largest reviews, Best and colleagues (**2014**) conducted a systematic narrative review of 43 studies conducted between 2003 and 2013 focused on the association between online communication/social media and well-being. Notably, their review included studies with wide ranging methodologies (e.g., other reviews, qualitative studies) and operationalizations of digital technology use (e.g., technology-related problems and technology addiction alongside quantity of many different types of technology use). Across studies, they observed contradictory evidence of mixed, null, and positive associations and emphasized the lack of robust causal research regarding the impact of social media on mental well-being among young people. With these limitations in mind, the authors then speculated on potential positive and negative impacts of social media for adolescents. Potential benefits of social media engagement that were identified included: increases in self-esteem, perceived social support and social capital, safe identity experimentation, and increased opportunities for self-disclosure. Specific potential harms of

social media for well-being that were identified included: increased social isolation, depression, and cyberbullying.

In a 2017 systematic review, McCrae, Gettings and Pursell (**2017**) conducted a more focused review examining the association between social media use and depressive symptoms among children and adolescents (aged 5–18). Only 11 studies met eligibility for inclusion in the quantitative meta-analysis (focused on social networking sites and usage, restricted to English language publication, and conducted in general vs. clinical samples) resulting in a total N for the analysis of 12,646. The authors documented a small, but statistically significant, association between social media usage and depressive symptoms ($r = .13$, 95% CI: $-.05$ to 0.20), but noted the small number of studies, heavy reliance on cross-sectional designs (for 6 of the 11 studies), and difficulty in interpreting the clinical significance of the findings due to the wide variation observed in sample sizes, methods, and results. The most recent systematic review in 2019 restricted the range of adolescents between 13 and 18 years of age and, again, only identified a small number of studies ($N = 13$) that met criteria for inclusion (Keles, McCrae, & Grealish, **2019**). Eligibility for inclusion was determined based on age (13–18), measurement of social media usage as the exposure, measurement of depression, anxiety, or psychological distress by a validated instrument, and publication in peer reviewed journal, available in English. Of the 13 studies, 12 studies were cross-sectional. Again, the authors observed a general pattern of associations between social media usage and mental health problems, but noted that methodological limitations, the reliance on cross-sectional designs, and failure to include relevant mediators and moderators of associations, limited conclusions that could be drawn about the nature of this association. Importantly, they highlighted the lack of longitudinal and experimental research in this area and, as such, emphasized that the relationship between social media and depression should be characterized in correlational versus causal terms.

The remaining three reviews included a mix of adults and adolescents in the sampling frame. Conclusions were consistent with those summarized for the adolescent populations above in that cross-sectional research designs, retrospective reporting of symptoms and digital technology usage, and small and mixed patterns of associations were the norm and often limiting factors in drawing reliable conclusions in this area (Baker & Algorta, **2016**; Seabrook et al., **2016**). For example, in a 2016 review examining the association between frequency or time spent on SNS and depression, eight reported small positive associations, while twice as many found nonsignificant associations (Seabrook, Kern, & Rickard, **2016**). The authors concluded that the inconsistency across studies and lack of common themes or reproducible findings when varying measures of SNS use were employed suggested that any association between social media and depression is likely to be conditional on a number of moderating factors and sensitive to variations in usage patterns, pre-existing vulnerabilities, and context. More recently, Huang (**2017**) performed a meta-analysis across 67 independent samples (61 studies), which included a mix of adolescents and young adults ($N = 19,652$). They reported that the mean correlation between time spent on social networking sites (SNS) and psychological well-being (comprised of self-esteem, life satisfaction, loneliness, and depression) was $r = -0.07$ (95% CIs $= -.04$ to $-.09$), with associations for loneliness and depression that ranged from r's $= -0.08$ and $-.11$, respectively. Main effects were not moderated by sample age or gender.

Table **S1** provides additional details of the studies included in the six reviews which met inclusion criteria (adolescent sample; empirical analysis; available in English; measure of extent of digital technology use or engagement [i.e., studies which include only measures of technology-related problems or 'technology addiction' excluded]; measures relevant to mental health [e.g., depression, anxiety, psychological well-being, loneliness, self-esteem]). The studies are summarized with respect to: the study design (cross-sectional, longitudinal, experimental), year of data collection, sample country, age of participants, measures of mental health and digital technology usage, and whether the study suggested that engagement with digital technology is harmful, helpful, or neither/unclear. Four main findings emerge from a review of the adolescent-focused studies detailed in this table. First, the majority of studies conducted to date are derived from cross-sectional surveys. Of the 29 studies included in Table **S1**, only 4 (14%) are longitudinal and only two studies included an experimental or quasi-experimental design. As a result, the ability to make causal inferences is extremely limited and does not allow for conclusions regarding whether increased time online or engagement with social media use *causes* changes in young people's mental health.

The inconsistencies in the evidence reviewed and correlational nature of research to date raises questions regarding how such a strong causal narrative has emerged regarding social media usage, time online, and adolescents' mental health. An often-cited study when promoting the beneficial effects of reducing screen and social media time among adolescents comes from a study of Danish adults who were randomly assigned to take a break from Facebook. In this study, those assigned to take a Facebook break reported greater life satisfaction and more positive emotions compared to the control condition who continued their Facebook use as usual (Tromholt, **2016**). Results also suggested stronger effects among those whose use was already potentially problematic (as evidenced by heavy use, passive use, and envy of others on Facebook). However, the validity of this study and generalizability to adolescents is limited due to the fact that participants were unpaid *adult* volunteers recruited via Facebook ads, 86% of whom were women with an average age of 48 years, and all of whom were not blind to their condition prior to reporting on whether their mental health had improved after giving up Facebook. In contrast, experimental studies with college students have demonstrated that virtual communication can have positive impacts, with randomization to instant messaging and virtual communication leading to reductions in distress (Dolev-Cohen and Barak, **2013**) and replenishment of self-esteem and perceived relational value after social exclusion (Gross, **2009**). Additional experimental work with adolescent populations is sorely required, especially those that ensure participants are blind to study conditions and measure mental health using multiple informants.

Second, many studies have relied soley on screen time as the index of engagement with digital technologies. Screen time is typically measured as the number of minutes or hours youth spend on a device or engaged in a particular online activity each day. The reliance on screen time metrics is a problem given that all screen time is not equal with respect to potential risks and benefits. Spending time on devices and screens is now a required part of many adolescents' educational experiences and means of communication throughout the day with family and friends. Mobile devices have also become a primary means of accessing multiple modes of entertainment that have always appealed to adolescents, including streaming videos and movies, music, and gaming. In addition, screen time measures are typically gathered via retrospective

self-reports from youth, which introduces recall bias, and are assessed alongside self-reported measures of mental health, which introduces common method or rater bias (Podsakoff, MacKenzie, Lee, & Podsakoff, **2003**) into the research design and analysis. Finally, reducing a complex and multi-dimensional set of experiences into a single index of retrospective self-reports of the amount of time that youth spend in front of screens does not correspond well with objective measures of time spent online (correlations between objectively measured and retrospectively reported screen time are estimated to be ~r = .20 (Ellis, **2019**)). Across the 29 studies reviewed in Table **1**, only two included objective or informant-rated measures of screen time or social media usage, and the majority did not go beyond relying on time-based summaries (e.g., 2 hr per day online) to characterize usage.

Third, most studies to date have relied on relatively small, nonrepresentative samples, which limits the ability to both generalize back to the larger population of adolescents and to conduct adequately powered interaction tests to identify which subpopulations may be most at risk, although there are exceptions to this trend (e.g., the Monitoring the Future Study and Millennium Cohort Study described in the next section). The vast majority of studies have been drawn from high-income and high-resource settings. Rates of mobile phone access and usage vary widely across low- to high-income settings, and potential impacts on adolescent health and well-being are likely to vary as well. This type of selective sampling and recruitment limits the generalizability of research findings and has resulted in conclusions being drawn almost exclusively from WEIRD (Western, Educated, Industrialized, Rich and Democratic) societies, an approach that is likely to heavily skew conclusions about potential impacts on adolescent mental health to a minority of adolescents worldwide (Henrich, Heine, & Norenzayan, **2010**). The paucity of data from these settings impedes our understanding of potential impacts of digital technologies in middle- and low-income settings, where the vast majority of youth in the world are currently coming of age (World Health Organization, **2019**).

Fourth, while a significant amount of time has been spent discussing issues related to negative impacts of digital technologies on adolescents, most empirical research on the effects of digital technologies on well-being has focused on young children or adults (as evidenced by the small number of studies that met inclusion for the quantitative analyses above). More specifically, the early adolescent period has been neglected in prior research, despite the fact it is likely to be one of the most relevant times for understanding linkages between mental health and social media, as young people are making the transition biologically and socially to adolescence and, simultaneously, entering social media platforms and more complex digital environments. None of the studies reviewed above tested, or were powered to test, whether associations differed by developmental stage. Instead, when adolescence was considered separately, adolescents were treated as a homogenous group. Progress has been made in other areas with respect to mapping new media use on trajectories of adolescent brain development during this period (Crone & Konijn, **2018**); however, what is currently needed is a developmentally calibrated evaluation of the fit between the affordances and constraints of digital technologies and the core developmental tasks, competencies, and vulnerabilities that characterize the adolescent period more generally, and the transition to adolescence more specifically (Dahl, Allen, Wilbrecht, & Suleiman, **2013**). Practically, there has been a blurring of the discussion in legal, clinical, and policy contexts between protections and screen time rules that are required for young children

versus the approaches required to help support and scaffold adolescents as they learn to navigate complex digital ecologies more independently.

To summarize, there has been widespread speculation that increases in depression and anxiety are being driven by changes in the way that adolescents interact with each other through social media and time online. The claims are that adolescents are increasingly losing out on opportunities for face-to-face interaction (Turkle, **2017**), are likely to be harassed and victimized frequently online (Hamm et al., **2015**), and are under constant assault by idealized and carefully curated images that may lead to upward social comparisons, envy, and, in turn, lower well-being and increasing rates of depression (Appel, Gerlach, & Crusius, **2016**). However, a review of the existing research demonstrates inconsistent and primarily small associations between the quantity of digital technology usage and mental health, with no way to discern cause from effect. Additional research that is longitudinal, expands beyond WEIRD societies, integrates multiple indices of digital technology usage and well-being, embeds experimental or quasi-experimental design features, and includes a sufficient, and representative number of young people spanning the entire adolescent period (ages 10–24) is needed. At present, narrative reviews and meta-analytic work do not support causal claims, or even strong and consistent correlational patterns, linking adolescents' digital technology usage with mental health problems.

Evidence Base 2. Large-scale and multiple-cohort studies

Similar to findings from systematic reviews and meta-analyses, the most recent and rigorous large-scale and preregistered studies have not found strong support for a robust linkage between adolescents' technology use and well-being. Using specification curve analysis across three national data sources of adolescents ($N > 350,0000$), two based in the United States and one in the UK, Orben and Przybylski (**2019**) demonstrated that choices related to the specification of variables capturing digital technology use, adolescent well-being, and confounders can generate a myriad of effect sizes, with the most likely association being exceedingly small and explaining a small portion of the variance in well-being. More specifically, across their 3,221,225,472 analyses, technology use accounted for less than 1% (0.4%) of the variation in well-being. Again, the remaining small cross-sectional association between digital technology usage and well-being provided no credible way to disentangle cause from effect. In a related 2017 preregistered study of over 120,000 English adolescents, the authors found no robust associations between mental well-being and moderate use of digital technology (which characterizes use by most adolescents), with a measureable 'albeit small' negative associations (less than 1% of the variation explained) for those with high levels of engagement (Przybylski & Weinstein, **2017**).

In a recent re-analysis of the Monitoring the Future Study (notably the same study and data that was used to signal initial alarms regarding the connection between social media/digital technology usage and depression; (Twenge et al., **2018**)), daily social media use was *not* found to be a moderately strong or consistent risk factor for adolescents' depressive symptoms (Kreski et al., **submitted**). The study analyzed data from 8th and 10th grade students, across 2009 to 2017, to assess the relationship between self-reported daily social media use and depressive symptoms. The most consistent associations observed, after adjusting for confounding and stratifying by depression propensity, indicated that girls (but not boys) who had the *lowest* propensity for depression had slightly increased risk for depressive symptoms with daily social media use

exposure. Interestingly, as daily social media use has increased among adolescents in the United States, the associations between social media use and depressive symptoms across 2009 to 2017 have decreased in magnitude. Thus, while social media usage and depression have been both increasing over the last decade in the United States, the linkage between the two is mostly nonexistent, and when associations are detected, evidence indicates that they have become weaker over time. Across these large-scale cohort studies, the authors conclude that, as currently measured, social media usage is unlikely to be a meaningful contributor to increased depressive symptoms among youth in the United States and United Kingdom.

Evidence Base 3. Daily diary and ecological momentary assessment studies

Studies that have followed adolescents intensively using diary studies or Ecological Momentary Assessment (EMA) are also converging on a similar set of findings as those reviewed above, with small associations that vary in direction between positive, negative and null. Diary and EMA research designs allow for 'in the moment' data capture as young people report on their lived and recent experience and, more generally, enhance recall and produce more reliable and complete data on daily experiences (Shiffman, Stone, & Hufford, **2008**). More specially, these methods have been shown to reduce the recall bias that is inherent in retrospective self-reports of experiences (which as detailed above is quite poor for estimates of time spent using technology; Ellis, **2019**) and facilitate more accurate assessments of time allocation and mental health symptoms over the course of the day. Obtaining high density observations of both digital technology usage and mental health also allows for an examination of within-person linkages between these experiences over time while holding all stable all factors that are fixed within the individual and/or across time.

In our most recent EMA study (Jensen, George, Russell, & Odgers, **2019**), adolescents were tracked on their smartphones to test whether more time spent using digital technology was linked to worse mental health outcomes. The study surveyed a population representative sample of over 2100 youth, aged 11–15, followed by a 14-day ecological momentary assessment (EMA) via mobile phones with a representative sub-sample of approximately 400 youth in 2016–2017. The EMA portion of the study yielded 13,017 total observations over 5,270 study days and results demonstrated that adolescents' baseline technology usage did not predict later mental health symptoms. Reports of mental health symptoms were gathered from the adolescents three times a day, and they also reported on their daily technology usage each night. There was no evidence that adolescents' reported mental health was worse on days when they reported spending more versus less time on technology. When associations were observed, they were small and in the opposite direction that would be expected given recent concerns about digital technology damaging adolescents' mental health. For instance, teens who reported sending more text messages over the study period reported feeling better (less depressed) than teens who were texted less frequently. These findings are consistent with our prior research with adolescents deemed at risk for substance use and externalizing problems, where more time spent online, texting, and a greater number of texts sent were associated with *less* same day anxiety, and more texts sent were also associated with less same day depression, although small same day linkages with increased externalizing problems were also observed (George et al., **2018**).

EMA studies among older populations have generated mixed findings. For example, in a study of college students using experience sampling, no significant associations emerged between daily social networking site use and depression (Jelenchick, Eickhoff, & Moreno, **2013**). In an EMA of adults, momentary supportive online interactions were associated with momentary positive effect, but were not related to momentary negative affect (Oh, Ozkaya, LaRose, **2014**). In contrast, another experience sampling study (Kross et al., **2013**) showed that quantity of Facebook use was associated with worse affect at the next time point (a lagged effect), but not the inverse (affect did not relate to next time point Facebook use). This study concluded that this effect was not attributable to loneliness, nor was it moderated by other risk factors.

Finally, a related and recently reported preregistered study from the United Kingdom examined associations between adolescents' digital technology usage and life satisfaction over time (Orben, Dienlin, & Przybylski, **2019**) using repeated within-person assessments to disentangle between-person associations from within-person effects. Data were drawn from a large UK Household Longitudinal study, Understanding Society, which included 12,672 10- to 15-year-olds. The authors applied specification curve analysis and reported that across models, results were inconsistent, tended by be conditional (more likely to be present among females) on gender, with results that varied widely depending on how the data were analyzed. Most reported associations were small ('arguably trivial' as characterized by the authors) and in cases where stringent statistical controls were used, associations did not differ significantly from zero in over half of the models that were fit to the data. The authors concluded that, across the population (between people) social media use was not a strong predictor of adolescents' life satisfaction and, over time, associations were likely to be reciprocal, small at best, stronger for females and largely dependent on the analytic approach adopted when analyzing the data.

To summarize, a review of meta-analytic work, large-scale preregistered studies, and intensive daily and momentary assessments provides little evidence that engagement with digital media has substantial associations with adolescents' mental health symptoms at the population level. It is also worth noting that one of the primary studies that has been frequently cited as a source of panic related to a possible connection between social media and depression is the Monitoring the Future Study in the United States. This paper (Twenge et al., **2018**) reported on a correlation that accounted for <1% of the variation in depressive symptoms; that is 99.666% of the variation in adolescent's depressive symptoms was due to other factors, and the small correlation between digital technology usage and depression (0.4%) was cross-sectional and was estimated based on both self-reported depressive symptoms and technology usage. Similar to the vast majority of other studies reviewed here, there was no way to sort out cause from effect in this study. While it is true that small effects can have clinically meaningful and important implications for public health, this requires that the effects are causally estimated and there is compelling evidence of directionality and impacts. To date, the study designs and analytic approaches in this field have not been sufficient to support causal claims nor do they warrant the widespread panic related to smartphones, social media and adolescent mental health.

Over the last year, other research teams have analyzed these same data (Kreski et al., **submitted**; Orben & Przybylski, **2019**) and reported similar small initial associations between social media use and depressive symptoms. However, there are two important differences in the recent reporting from these same data. First, there has been an acknowledgement that results are highly

dependent on how the models are specified and that associations are greatly reduced once potential confounders and alternative specifications are considered. Second, even when the other teams have reported on the same initial small associations (using the same data set), the translation of the results has been in stark contrast to the message conveyed by the initial reports. That is, the message communicated from the recent analyses based on these data has been that there is no evidence of practically meaningful linkages between social media and contemporary adolescents' depressive symptoms. The fact that the same data and effect sizes are reported across studies, but that they are communicated in dramatically different ways to the public, practitioners, and importantly to adolescents themselves, raises a number of questions related to the responsible and reproducible reporting of findings with public health importance from large, public use databases. That is, the stark contrast in how the findings are communicated highlight the need to exercise caution and ensure that policies, parenting practices and the allocation of public health resources are based on robust facts versus common fears regarding how digital technologies influence young people (Uhls, **2016**).

Overcoming fears and forging future directions for adolescents in the digital age

Given the lack of evidence for strong connections between the amount of time that adolescents spend on social media and related technologies and their mental health, the question becomes: why has digital technology so quickly and adamantly been identified as a cause of recent upticks in adolescent depression? Some have suggested that each generation is able to easily find fault in the choices, time-use, and overall character of the next and that moral panic around new technologies is an expected and well established cycle that plays out as new technologies are introduced (Uhls, **2016**). Another possibility is that the instincts and parental/clinical intuitions among those connecting social media with depression and anxiety are correct and the scientific community has simply not caught up or kept pace with new technologies in ways that allow us to capture their true impact and measurable effects. While future research may identify clear or stronger linkages, at present the available evidence falls short of the standard of proof required to identify digital technology use as a putative environmental cause of adolescent mental health problems. The scientific and medical community would not accept two lines traveling together as sufficient evidence to determine the cause of childhood cancer—a disease which also takes thousands of young people's lives each year—we should not accept this standard in linking adolescents' increasing depression and suicide with increases in social media use. Understanding the factors driving increasing rates of depression and suicide among young people constitutes a critically important health crisis. If social media and smartphones play a casual role, even a small one, we need to be able to effectively respond. To ensure that the scientific community is able to keep pace with the rapid evolution of new digital technologies and their potential linkages to adolescent well-being, careful attention to the following four issues will be required:

1. Adolescents' online risk often mirrors offline vulnerabilities. Future research is needed to understand why offline risk signals online problems and to support young people who are struggling in both spheres.

Adolescents with a history of prior victimization are more likely to be bullied, victimized, and solicited online (Kowalski, Giumetti, Schroeder, & Lattanner, **2014**). Similarly, adolescents struggling with offline mental health problems are more likely to seek out more negative online

content and spend more time passively 'lurking' versus engaging with others in online spaces (Underwood & Ehrenreich, **2017**). Offline resources also matter, as youth from low-income families tend to report more negative spillover of negative experiences on social media to offline conflict, fights, and trouble at school (Odgers, **2018**), while youth from more supportive and well-resourced homes are more likely to receive more scaffolding from adults and have more positive experiences online (Mascheroni & Ólafsson, **2014**). Consistent with a 'rich-get-richer' model regarding who benefits most from time online (Kraut et al., **2002**), longitudinal research has shown that children with higher quality social relationships (e.g., better reported relationships with friends, caregivers, siblings, and teachers) were more likely to become more frequent users of online communication as adolescents (email, chats, or messaging) and, in turn, have more cohesive offline and online friendships (Lee, **2009**).

Moving forward, research that integrates measures of underlying mental health risk using, for example, family history, childhood risk, genetic propensity, or related markers of future mental health are required to trace how pre-existing vulnerabilities for mental health problems influence patterns of online usage and engagement and test whether pre-existing mental health risks moderate impacts of digital technology usage on well-being. A leading explanation for linkages between depressive symptoms and online engagement is that adolescents at higher risk for depressive symptoms may selectively use social media more, or differently. For example, youth who report psychological distress around their *online* activities and describe their technology use as including distressing or problematic elements, are also more likely to report psychological distress in their *offline* lives (Andreassen et al., **2016**; Augner & Hacker, **2012**; Morrison & Gore, **2010**). Rigorous tests of reverse causation are required given that digital technology's more negative sides often appear among subgroups of adolescents with existing offline vulnerabilities (George & Odgers, **2015**). At present, the over reliance on cross-sectional and correlational data make it impossible to determine whether problematic technology usage leads to mental health problems, or whether those with existing vulnerabilities are simply more likely to use technology in unhealthy ways. When considering youth with existing vulnerabilities for mental health problems, there is also a danger in assuming a one-size-fits all explanation for this very diverse subgroup of adolescents, and for the influence of digital technology over time and across contexts. In general, there is a need to move beyond estimating one parameter to describe associations between adolescents' digital technology usage and mental health, and importantly, not to simply replicate this ecological fallacy error when thinking about the population of adolescents (estimated at 1 in 5) suffering from a mental health problems. Instead, the next generation of digital mental health research for youth needs to ask when, under what conditions, and for whom does engagement with digital technology create opportunities, amplify risk, or neither. Both theoretically and empirically driven approaches (e.g., specification curve analyses) are required to better understand this type of heterogeneity in linkages across time, development, contexts, and adolescents.

Scientifically, accounting for unmeasured confounding is a critical step in being able to understand mechanisms and model the interplay between offline and online risk. Practically, understanding how online and offline contexts interact is required to develop effective strategies for parenting and policies in the digital age. If, for example, online problems are largely determined by offline vulnerabilities, then much of our existing knowledge of how to promote healthy development among young people should translate into what has been described by

many as a foreign digital landscape. For example, adolescents who are more vulnerable to upward social comparisons and especially sensitive to peer and social rejection in offline social settings may benefit from being more closely monitored and supported when engaging in online interactions. Similarly, promoting supportive parent–child relationships that encourage child disclosure, versus the adoption of overly restrictive of coercive parental monitoring strategies, may be equally effective in learning about young people's unmonitored activities in both offline and online contexts. Just as interventions to prevent bullying within school settings have proven effective for reducing cyberbullying (Williford et al., **2013**), parenting, and support strategies developed for use in offline spaces may translate well into supporting adolescents formation of healthy online relationships, interactions, and experiences.

2. Screen time is no longer a useful construct, but it still dominates research and public discourse. Researchers, policymakers and parents need to move beyond a singular focus on screen time and change the conversation to more accurately reflect how adolescents interact with digital technologies in their daily lives.

Most measures of digital technology usage relied on in the studies reviewed above are reduced to a single measure of time spent online, or more recently, to time spent on a particular platform or type of online behavior. However, the *nature* of online interactions is likely to be more relevant for understanding any potential mental health effects than is a global measure of the number of minutes or hours a youth spends online. Associations between online technology usage and mental health vary depending on the type and features of online activities. For example, online social networking site use tends to be related to *less* internalizing, to the extent that it includes positive interactions, enhances social support, and facilitates social connectedness, and tends to be associated with more internalizing in instances when it is excessive, reduces time spent in in-person interactions, and in which interactions are negative or involve social comparisons (Clark, Algoe, & Green, **2018**; Seabrook et al., **2016**). Indeed, more nuanced studies of online activities among adolescents suggest that it is not the frequency but the type of social media usage that is associated with their depressive symptoms (Nesi, Miller, & Prinstein, **2017**). It is also the case the social networking sites and platforms are evolving rapidly, from profiles that were originally static portraits of the owner to dynamic 'toolkits' that allow for interconnected streams of influence, conversations, and a mix of corporate, private, and public representations and uses of information and data (Ellison & Vitak, **2015**). Adolescents are also engaging with multiple social media platforms which can change rapidly over time, creating challenges for researchers trying to capture the complex nature of their interactions and experiences in the online world. One innovative approach for capturing adolescents' online engagement, that is not dependent on platform, is the EARS (Effortless Assessment of Risk States) which captures multiple indices of a person's social and affective behavior via their naturalistic use of a smartphone, including the integration of a custom keyboard that logs, with the adolescents' permission, text that is entered across social media platforms and other applications (Lind, Byrne, Wicks, Smidt, & Allen, **2018**). Additional investments in developing and testing these types of flexible tools for research and clinical use are required, including approaches that include codesign and interactive testing with adolescents themselves.

More generally, in order to effectively move beyond a reliance on screen time metrics, alternative and less burdensome methods of assessing mental health via mobile technologies are

required, including, for example, scraping social media data to identify mental health risk (De Choudhury, Gamon, Counts, & Horvitz, **2013**), and passively, and with consent, passively extracting data on the environment, movements and digital traces left by young people that may be most relevant to their mental health (Mohr, Zhang, & Schueller, **2017**; Nelson & Allen, **2018**).

3. Digital technologies provide new opportunities to support all, but especially vulnerable, adolescents

The fears around the potential negative impacts of new technologies on young people have consumed much of the attention of policymakers, parents, and the medical community. What has been discussed less frequently is how new technologies could be leveraged to foster social connection and engage adolescents in ways that support their mental health. An emerging body of research suggests that if provided under the right conditions, online supports and information can provide valuable forms of both instrumental and social support. Young people report going online frequently to seek out health information (Kauer, Mangan, & Sanci, **2014**) and, those with lower social and emotional well-being, are more likely to report going online to seek support and to feel better about themselves (Rideout & Fox, **2018**). Social networking sites may be used by young people in the face of setbacks (Toma & Hancock, **2013**) and many young people turn to social media for support and advice related to their mental health symptoms (Pretorius et al., **2019**), with some research suggesting that adolescents with moderate to severe depressive symptoms may be more likely (2×) than their peers to turn to social media for emotional support (Rideout & Fox, **2018**).

Supportive peers and networks carry important protective effects for young people's mental health, and there is increasing evidence that online communication may be a critical way that peer-to-peer support and communication occurs among adolescents. As reviewed above, digital communication is often used to support adolescents' peer relationships by creating opportunities for displays of affection, intimate disclosure, and offline activities (Yau & Reich, **2017**). Many studies now report positive associations and substantial overlap between adolescents online and offline interactions and relationship quality. For example, adolescents with stronger offline networks often report more robust online networks and, although increased time online tends to displace offline time with parents, parent–child relationships do not appear to be negatively influenced by these changes (for a review see George & Odgers, **2015**). Interestingly, early experimental studies showed that virtual communication may help adolescents 'bounce back' following social rejection (Gross, **2009**) and, as such, may serve as a tool for providing social support when youth are separated from parents or loved ones physically.

The promise of digital technologies is that clinicians, parents and researchers can now connect with adolescents where they spend much of their time and reach young people who may otherwise never enter a clinic or research laboratory. Digital tools offer the promise of taking evidence-based interventions to scale, reducing disparities in access to effective treatments and supports, and removing barriers to treatment resources (Lind et al., **2018**). Peer-to-peer training and supports (e.g., mental health first aid), online support and referral systems (e.g., seven Cups of Tea) and the translation of evidence-based therapies, such as cognitive behavioral therapy, into digital format and delivery systems, has provided proof of principal that digital technologies can be used to connect to and support young people. However, measurable progress in the

development of interventions that support youth in online spaces will required interdisciplinary teams that bring expertise is not only the adolescent mental health, but also include those with expertise in communications, computer science, educational and learning sciences, pediatrics, and cultural anthropology/youth culture.

Despite the promise of supporting youth via digital technologies, a number of challenges remain, including the foundational problem that digital platforms and tools have not been designed or tailored developmentally for adolescents (Odgers, **2019**). Instead, most wellness and mental health apps have been targeted toward adults or made for adults to use with or for their young children. Digital technologies are likely to provide a number of affordances that could be used to maintain and strengthen offline relationships, but relatively few evidence-based intervention efforts currently exist. The challenge will be moving past the 'screen time debates' and toward a set of productive investments in making digital technologies work in ways that effectively support youth.

4. The rapid adoption of new digital technologies may amplify existing inequalities in adolescent mental health and well-being. Equitable and inclusive research, policies, and intervention efforts are required to reduce the 'new' digital divide.

Historically, the introduction of new technologies have tended to benefit those who are best positioned to take advantage of the affordances that they provide. There is emerging evidence of 'rich-get-richer' effects related to adolescents' online opportunities and experiences. For example, in our population representative sample of US adolescents, youth growing up economically disadvantaged families were equally likely to have access to mobile devices but were more likely than their more affluent peers to perceive negative spillover of online experiences to problems in their offline lives (e.g., fights, trouble at school) (Odgers, **2018**). In studies across Europe, children from wealthier versus poorer homes are more likely to receive two or more forms of active mediation of Internet safety by their parents (Mascheroni & Ólafsson, **2014**) and in the United States, adolescents (aged 13–18) from low-income families spend twice as much time passively consuming media than their peers from high-income families (with incomes >100,000 per year), and on average, spend about three more hours per day on screens.

Traditionally, the 'digital divide' has referred to differential access to new technologies. That gap still exists, but in many countries, it is shrinking (OECD, **2016**). What we may be seeing now is the emergence of a new kind of digital divide, where differences in online experiences are amplifying risks among already vulnerable adolescents. Lower versus higher income youth are increasingly living in two separate physical worlds as neighborhood, school, and other forms of segregation increase in the United States and elsewhere (Putnam, **2016**); the concern is that this segregation of access, opportunities, and experiences will replicate itself online. The introduction and broad reach of digital technologies offers the promise of reducing health and educational disparities, but the fear is that if adequate supports are not provided, or technologies are not tailored, inequalities will be further amplified. As young people come of age in an increasingly unequal and stratified world, it is essential that equity with respect to access, experiences, and opportunities in both online and offline spaces is afforded (George et al, in press).

Conclusions

Digitally, there have been unprecedented and rapid changes in how adolescents spend their time, connect to the world, and communicate with each other. Mobile device ownership and social media use have reached unprecedented levels among adolescents. Perhaps this is not surprising as digital devices, and the affordances that they provide, are especially strong attractors for young people given their heighted need for affiliation, social approval, and novelty seeking. As adolescents spend an increasing amount of time interacting with digital technologies, there is an urgent need to both understand effects of this usage and leverage new technologies in ways that support versus harm their mental health and well-being.

Unfortunately, most of the attention given to adolescents' digital technology usage and mental health has focused on negative effects and has been based on weak correlational data. Over the past decade the rapid uptake of social media has fueled fears that social media platforms are causing serious mental health problems. These fears have been extended down to children and were initially promoted based on scant evidence in a statement issued by the American Academy of Pediatrics Council on Communications and Media warning of the dangers of 'excessive Facebook' use among children and adolescents (O'Keeffe & Clarke-Pearson, **2011**) and have since been fueled by a number of public calls to action on to protect children and adolescents from social media (Rosenstein & Sheehan, **2018**). Research since that time has been mostly correlational, tends to focus on adults versus adolescents and has generated a mix of small positive, negative, and null associations. Most recently, large-scale preregistered studies have reported a lack of sizable or practically meaningful associations between adolescents' digital technology usage and well-being.

Digital technologies are here to stay, and have become pervasive in the lives and relationships of young people. Practically, it is critical to know whether recent fears about adolescents' digital technology usage are justified as professional organizations release guidelines for parents, educators, and institutions based on incomplete and often contradictory findings. Policies restricting adolescents' access to new technologies are advocated, but may be ill advised if new technologies are being used as a valuable source of social support or are required in order to build digital and interpersonal (digitally mediated) skills for economies of the future. With respect to mental health, what is most needed is a focus on how to reach young people when they are in crisis and when support is needed most.

A theme that has consistently emerged across this research area relates to the overlap between offline and online risk. This finding challenges the assumption, and a common message to parents, that the digital landscape and its effects are too complex, fast moving, or nuanced to fully understand or for us to help young people effectively navigate. A more likely explanation is that many of the same principles that guide healthy development and inform effective parenting will apply when supporting youth in their online activities and experiences. If this is true, then the good news for parents and policy makers is that existing evidence-based interventions and strategies may look different but will still be effective in supporting youth in the digital age.

Acknowledgements

Key Points
- Adolescents are early and enthusiastic adopters of digital technologies and are increasingly spending their time connecting to the online world and to each other through their devices. This constant connectivity has led to concerns that time spent online may be negatively impacting adolescents' mental health and well-being.
- We synthesized recent findings across meta-analytic studies and narrative reviews, large-scale and preregistered cohort studies, and intensive assessment studies tracking digital technology use and mental health across time.
- Most research to date has been correlational, cross-sectional, mixed in terms of the directionality, and have resulted in small associations which leave no way of separating cause from effect.
- We recommend that future research use experimental and quasi-experimental methods and focus on online experiences versus screen time as well as heterogeneity in effects across diverse populations of youth. Knowledge generated from this research should allow researchers and practitioners to leverage online tools to reduce offline disparities and support adolescents' mental health as they come of age in an increasingly digital and connected world.

Supplementary Table S1 is located at the end of this formatted document.

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Table S1.
Individual study details

Study	Study Design	Year(s) Data	Sample Country	Sample Age Mean (range)	Sample size	Measure of Mental Health	Measure of Digital Technology Use	Helpful, Harmful, or Null finding?
Apaolaza, V., Hartmann, P., Medina, E., Barrutia, J. M., & Echebarria, C. (2013). The relationship between socializing on the Spanish online networking site Tuenti and teenagers' subjective wellbeing: The roles of self-esteem and loneliness. Computers in Human Behavior, 29(4), 1282–1289. https://doi.org/10.1016/j.chb.2013.01.002	Cross-sectional Survey	2012	Spain	(12-17)	344	Loneliness Self-esteem Wellbeing	SR extent of SNS Use	Helpful
Banjanin, N., Banjanin, N., Dimitrijevic, I., & Pantic, I. (2015). Relationship between internet use and depression: Focus on physiological mood oscillations, social networking and online addictive behavior. Computers in Human Behavior, 43, 308-312.	Cross-sectional survey	Not reported	Serbia	18 (High school students)	336	Depressive Symptoms	SR Average time spent on SNS	Harmful Null finding
Barry, C. T., Sidoti, C. L., Briggs, S. M., Reiter, S. R., & Lindsey, R. A. (2017). Adolescent social media use and mental health from adolescent and parent perspectives. Journal of Adolescence, 61, 1–11.	Cross-sectional survey	Not reported	USA	15.27 (14-17)	226	Anxiety, Depressive symptoms, Loneliness	Child SR and parent report on SNS activity: number of accounts and frequency of checking	Harmful
Blomfield Neira, C. J., & Barber, B. L. (2014). Social networking site use: Linked to adolescents' social self-concept, self-esteem, and depressed mood. Australian Journal of Psychology, 66(1), 56–64. https://doi.org/10.1111/ajpy.12034	Cross-Sectional Survey	Not reported	Australia	14.6 (13-17)	1819	Mood Self Esteem	SR: having an SNS profile, frequency of SNS use, investment in SNS	Harmful
Bourke N. Online social networking and well-being in adolescents. Bachelor thesis, Dublin Business School, 2013.	Cross-sectional survey	Not reported	Ireland	13.66 (12-16)	204	Self-esteem, loneliness social anxiety	SR intensity of SNS use (Facebook), SR time online	Helpful Harmful
Devine, P., & Lloyd, K. (2012). Internet use and psychological well-being among 10-year- old and 11-year- old children. Child Care in Practice, 18(1), 5–22.	Cross-sectional Survey	2009	Northern Ireland	(10-11)	3657	Psychological Wellbeing	SR: access to and use of television, mobile phones, computers, the Internet; frequency of SNS use; frequency of Multi-player Online Gaming	Harmful Null finding

Reference	Study design	Year	Country	Age	N	Emotional state	Media use	Finding
Dolev-Cohen, M., & Barak, A. (2013). Adolescents' use of Instant Messaging as a means of emotional relief. Computers in Human Behavior, 29(1), 58–63.	Quasi-Experiment	Not reported	Israel	(14-18)	150		Engaging in Instant Messaging	Helpful
Dumitrache, S. D., Mitrofan, L., & Petrov, Z. (2012). Self-image and depressive tendencies among adolescent Facebook users. Revista De Psihologie, 58, 285–295.	Cross-sectional survey	Unknown	Romania	(16-17)	123	Self-image Depression	Coded quantity of posting identity-related information on Facebook	Harmful
Frison, E., & Eggermont, S. (2016). Exploring the relationships between different types of facebook use, perceived online social support, and adolescents' depressed mood. Social Science Computer Review, 34(2), 153–171.	Cross-sectional survey	2013	Belgium	15.44 (SD=1.71)	910	Depressed mood	SR active and passive SNS use (Facebook)	Harmful
Frison, E., Subrahmanyam, K., & Eggermont, S. (2016). The Short-Term Longitudinal and Reciprocal Relations Between Peer Victimization on Facebook and Adolescents' Well-Being. Journal of Youth and Adolescence, 45(9), 1755–1771. https://doi.org/10.1007/s10964-016-0436-z	Longitudinal (2 waves 6 months apart)	2014	Belgium	14.76 (12-19)	1621	Depression	SR time spent on Facebook (covariate)	Helpful
Gross, E. F. (2004). Adolescent internet use:What we expect,what teens report. Journal of Applied Developmental Psychology, 25(6), 633–649.	Cross-sectional Survey; 3 nightly diaries	2000-2001	USA	7th (M=12) 10th (M=15)graders	261	Anxiety (social) Daily life satisfaction Depression Loneliness	Daily SR of time spent using the Internet	Null finding
Gross, E. F. (2009). Logging on, bouncing back: An experiential investigation of online communication following social exclusion. Developmental Psychology, 45,1787–1793.	Experiment	2004-2005	USA	young adults (M=18.4) adolescents (M=12.5)	72 YA, 51 adolescents	Self esteem Social exclusion Negative affect	Engaging in Instant messaging	Helpful
Hwang, J. M., Cheong, P.H.,& Feeley, T.H. (2009). Being young and feeling blue in Taiwan: Examining adolescent depressive mood and online and offline activities. New Media &Society, 11(7), 1101–1121.	Cross-sectional Survey	2004	Taiwan	12-17 (M=15)	6341	Depressive mood	SR internet use frequency for communication, entertainment, information seeking.	Harmful
Morin-Major, J. K., Marin, M.-F., Durand, N., Wan, N., Juster, R.-P., & Lupien, S. J. (2016). Facebook behaviors associated with diurnal cortisol in adolescents: Is befriending stressful? Psychoneuroendocrinology, 63, 238–46. https://doi.org/10.1016/j.psyneuen.2015.10.005	Cross-Sectional Survey	Not Reported	Canada	14.5 (12-17)	88	Cortisol output Depression Self esteem	SR Facebook behaviors: frequency of use, network size, self-presentation, peer interactions	Null finding

Reference	Study design	Year	Country	Age	N	Outcome	Exposure measure	Finding
Nesi, J., & Prinstein, M. J. (2015). Using social media for social comparison and feedback-seeking: gender and popularity moderate associations with depressive symptoms. *Journal of abnormal child psychology, 43*(8), 1427-1438.	Cross-sectional survey	Not Reported	USA	14.6 (12-16)	619	Depressive Symptoms	SR Frequency of technology use on an typical day	Null finding
O'Dea, B., & Campbell, A. (2011). Healthy connections: Online social networks and their potential for peer support. Studies in health technology and informatics, 168, 133-140.	Cross-sectional survey	Not Reported	Not Available	secondary school students	74	Self-esteem Social support	SR Internet use Social networking sites	Helpful
O'Dea, B., & Campbell, A. (2011). Online social networking amongst teens: Friend or foe? Studies in Health Technology and Informatics, 167,133–138	Cross-sectional survey	Not Reported	Australia	14.31	400	Psychological distress Self esteem	SR Time spent interacting online (social networking sites)	Harmful
Pantic, I., Damjanovic, A., Todorovic, J., Topalovic, D., Bojoviclovic, D., Ristic, S., et al (2012). Association between online social networking and depression in high school students: Behavioral physiology viewpoint. Psychiatria Danubina, 24(1), 90–93.	Cross-sectional survey	Not Reported	Serbia	18.02	160	Depression	SR Time spent on TV and social networks	Harmful
Pea, R., Nass, C., Meheula, L., Rance, M., Kumar, A., Bamford, H., ... & Zhou, M. (2012). Media use, face-to-face communication, media multitasking, and social well-being among 8-to 12-year-old girls. Developmental psychology, 48(2), 327.	Cross-sectional survey	2010	USA	(8-12)	3461	Social well-being	SR Media use (Video, video games, email, texintg, IM, etc.)	Harmful
Quinn, S. V., & Oldmeadow, J. A. (2013). Is the iGeneration a 'We' generation?: Social networking use and belonging in 9–13 year olds. British Journal of Developmental Psychology, 31(1), 136–142.	Cross-sectional survey	Not Reported	England	11.83 (9-13)	443	Feelings of Belonging	SNS use and intensity (across 10 platforms)	Helpful
Sampasa-Kanyinga, H., & Lewis, R. F. (2015). Frequent use of social networking sites is associated with poor psychological functioning among children and adolescents. Cyberpsychology, Behavior, and Social Networking, 18(7), 380–385.	Cross-sectional survey	2013	Canada	14.1 (grades 7-12)	753	Mental health support Self-rated mental health Psychological distress Suicidal idealation	SR frequency of SNS use	Harmful
Sarriera, J. C., Abs, D., Casas, F., & Bedin, L. M. (2012). Relations between media, perceived social support and personal well-being in adolescence. Social indicators research, 106(3), 545-561.	Cross-sectional survey	Not Reported	Brazil	14.15 (12-16)	1589	Personal Well-being Social support	SR Interest in: Internet use, computer games, video games, computer, cell phone, television	Helpful Null finding

Reference	Design	Year	Country	Age	N	Outcome	Measure	Finding
Selfhout, M. H. W., Branje, S. J. T., Delsing, M., ter Bogt, T. F. M., & Meeus, W. H. J. (2009). Different types of Internet use, depression, and social anxiety: The role of perceived friendship quality. Journal of Adolescence, 32(4), 819–833. https://doi.org/10.1016/j.adolescence.2008.10.011	Longitudinal (2 waves 1 year apart)	Not Reported	The Netherlands	15.5 (14-17)	307	Anxiety Depression	SR Internet use for different purposes: communication (e.g. Iming) or passive surfing	Null finding
Tiggemann, M., & Slater, A. (2015). The role of self-objectification in the mental health of early adolescent girls: Predictors and consequences. Journal of Pediatric Psychology, 40, 704–711.	Cross-sectional survey	Not Reported	Australia	11.64 (10-13)	204	Self-objectification Body shame Dieting Depressive symptoms	SR time spent on: television; Internet; Facebook/Myspace	Harmful Null findings
Tsitsika, A. K., Tzavela, E. C., Janikian, M., Ólafsson, K., Iordache, A., Schoenmakers, T. M., … Richardson, C. (2014). Online social networking in adolescence: Patterns of use in six European countries and links with psychosocial functioning. Journal of Adolescent Health, 55(1), 141–147.	Cross-sectional survey	Not Reported	Greece, Spain, Poland, Netherlands, Romania, Iceland	15.8 (14-17)	10930	Internalizaion	SR time spent on SNS	Harmful
Valkenburg, P. M., Peter, J., & Schouten, A. P. (2006). Friend Networking Sites and Their Relationship to Adolescents' Well-Being and Social Self-Esteem. CyberPsychology & Behavior, 9(5), 584–590. https://doi.org/10.1089/cpb.2006.9.584	Cross-Sectional Survey	Not Reported	Netherlands	(10-19)	881	Social Self-Esteem (Well-being)	SR time spent on SNS	Null Finding Helpful
Van den Eijnden, R. J. J. M., Meerkerk, G.-J., Vermulst, A. a., Spijkerman, R., & Engels, R. C. M. E. (2008). Online communication, compulsive internet use, and psychosocial well-being among adolescents: A longitudinal study. Developmental Psychology, 44(3), 655–665. https://doi.org/10.1037/0012-1649.44.3.655	Longitudinal (2 waves 6 months apart)	2003-2004	Netherlands	13.37 (12-15)	663	Loneliness Depression	SR frequency of technology for: email, chat rooms, instant messaging	Harmful Null finding
Vernon, L., Modecki, K. L., & Barber, B. L. (2017). Tracking effects of problematic social networking on adolescent psychopathology: The mediating role of sleep disruptions. Journal of Clinical Child and Adolescent Psychology, 46(2), 269–283.	Longitudinal	2011-2014	Australia	14.4 (Grade 9-11)	874	Depressed mood Externalizing behavior	SR Investment in social media	Harmful
Yan, H., Zhang, R., Oniffrey, T. M., Chen, G., Wang, Y., Wu, Y., … Moore, J. B. (2017). Associations among screen time and unhealthy behaviors, academic performance, and well-being in Chinese adolescents. International Journal of Environmental Research and Public Health, 14(6). doi:10.3390/ijerph14060596	Cross-sectional survey	2016	China	(13-18)	2625	Well-being	SR Screen time	Harmful

Note. SR= Self-report, SNS= Social Networking Site